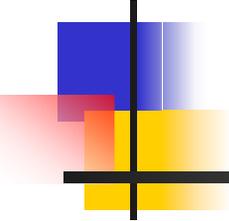


Antilock Braking Rulemaking Considerations

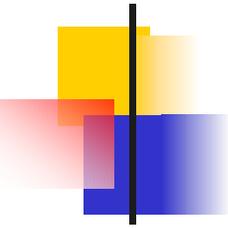


Sam Daniel

National Highway Traffic Safety Administration

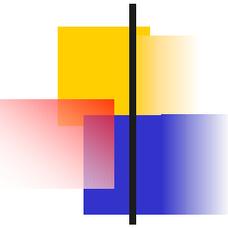
Andrew Snyder

Transportation Research Center, Inc.



Antilock Brake System (ABS) Presentation Overview

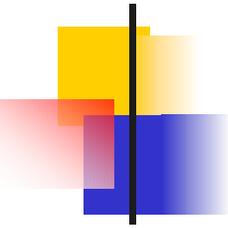
- General Approach to Rulemaking
- Antilock Brake System Definition and Features
- Light Vehicle ABS Rulemaking Notices
- Recent Light Vehicle ABS Effectiveness Research
- European ABS Requirements and Test Procedures and Compatibility with Agency Rulemaking Considerations



NHTSA'S General Approach To Rulemaking

Agency Considers Part 571 Rulemaking Under 3 Conditions

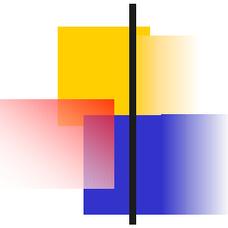
- 1) Crash Data Indicate that Rulemaking would Result in Safety Benefits (fatality and injury severity reduction)
- 2) Existing Standards Become Unenforceable due to Technology Changes or Compliance Test Problems
- 3) NHTSA is Required to Develop Standards by Congressional Mandate



Antilock Brake System Definition And Features

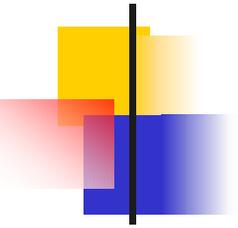
DEFINITION:

- ABS means a Portion of a Service Brake System that Automatically Controls the Degree of Rotational Wheel Slip during Braking by:



ABS Definition And Features - Cont'd

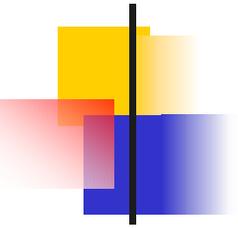
- 1) Sensing the Rate of Angular Rotation of the Wheels
- 2) Transmitting Signals Regarding the Rate of Wheel Angular Rotation to One or More Controlling Devices which Interpret those Signals and Generate Responsive Controlling Output Signals and
- 3) Transmitting those Controlling Signals to One or More Modulator Devices Which Adjust Brake Actuating Forces in Response to those Signals



ABS Definition And Features - Cont'd

Features

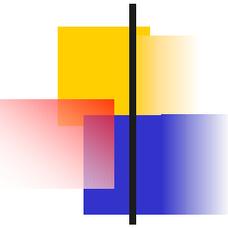
- ABS Reduces Stopping Distances on Most Road Surfaces, Especially Under Slippery Road Conditions (Low Coefficient of Friction)
- ABS Prevents Wheel Lockup thereby Reducing Loss of Control during Braking



Light Vehicle ABS Rulemaking Notices

1994 Advance NPRM, 59 FR 281 Antilock Brake Systems for Light Vehicles

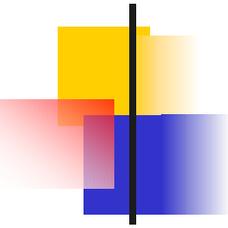
- Response to the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 Requesting that the Agency Initiate Rulemaking on Light Vehicle Braking Systems and other Safety Matters
- Requested Comments on Desirability of Mandating ABS for Light Vehicles



Light Vehicle ABS Rulemaking Notices - Cont'd

1996 Advance NPRM; Deferral of Rulemaking (61 FR 36698)

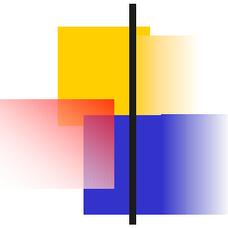
- Deferred the ABS Rulemaking Initiated in the 1994 ANPRM
- Announced Results of Crash Data that Determined that ABS-equipped Light Vehicles have Mixed Crash Experience with a Reduction of Accidents in some Crash Modes and an Increase in Accidents in other Crash Modes
- Predicted that a Significant Majority of Light Vehicles would be Voluntarily Equipped with ABS in next Five Years



Light Vehicle ABS Rulemaking Notices - Cont'd

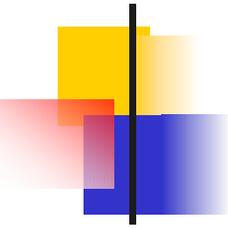
2002 Final Rule, FMVSS No. 138, Tire Pressure Monitoring System (67 FR 38704)

- In Response to OMB Suggestion about Mandating ABS, NHTSA Summarized Light Vehicle ABS Crash Data Analyses Conducted over the past 10 Years
- NHTSA Will Continue to Monitor Light Vehicle Real World ABS Performance and Consider Rulemaking to Require ABS on Light Vehicles If Crash Data Indicates that ABS Will Have Significant Safety Benefits



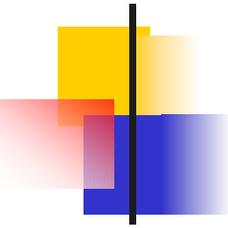
NHTSA Light Vehicle ABS Research Program Summary

- Conducted by Agency's Vehicle Research and Test Center (VTRC) – Initiated in mid-1990s
- Includes 7 Tasks in which Driver Behavior and Vehicle Dynamics Performance were Examined
- Telephone Survey (Task 2) in 1998 Indicated that many Drivers Did Not Know how ABS Affected Vehicle Performance or if their Own Vehicles were ABS-equipped



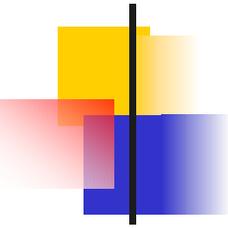
NHTSA Light Vehicle ABS Research Program Summary - Cont'd

- Telephone Survey also Determined that Some Driver Responses to Brake Pedal Feedback during ABS Activation was Inappropriate
- Braking Performance of a group of 1993-1997 Light Vehicles (Task 4) was Assessed with ABS Activated and ABS Deactivated
- Task 4 Determined that Vehicles Stopped in Shorter Distance with Improved Stability (Steering Control) with ABS Activated



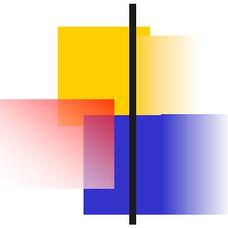
NHTSA Light Vehicle ABS Research Program Summary - Cont'd

- Driver Behavior in a Crash Imminent Situation (Task 5) was Examined on a Test Track and in a Vehicle Simulator
- Simulator Results Showed that Excessive Steering Can Occur during Crash Avoidance Situations, but Did Not Show a Significant Number of Road Departures
- Test Track Crash Avoidance Behavior Study found that Nearly All Subjects Braked and Steered During Crash Avoidance Maneuvers with Few Road Departures



NHTSA Light Vehicle ABS Research Program Summary - Cont'd

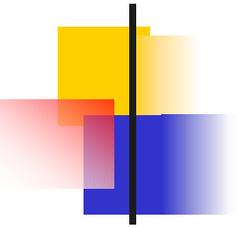
- Driver Risk Compensation (Task 7) Examined Whether Drivers Drove More Aggressively with ABS-Equipped Vehicles
- Unobtrusive Observation of Light Vehicle Drivers (Task 7.1) Revealed that Type of Brake System had No Significant Effect on Driving Speed Under the Conditions Examined
- The On-Road MicroDAS Study (Task 7.2) Gathered Naturalistic Driving Data that also Found that Type of Brake System had No Significant Effect on the Vehicle Performance Metrics Collected



NHTSA Light Vehicle ABS Research Program Summary - Cont'd

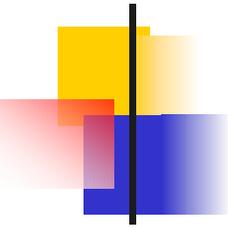
Tentative Program Conclusions:

- No Major Driver Behavior or Vehicle Performance Characteristics Have Been Found that Account for the Lack of ABS Safety Benefits
- Most Recent NHTSA Study Found that ABS-Equipped Vehicles were Involved in Fewer Crashes than non ABS-Equipped Vehicles
- No Significant Reduction has been Found in Overall Fatal Crash Involvement for ABS-Equipped Vehicles



Harmonized Brake Standards

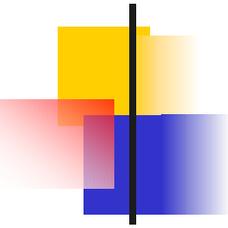
- The European Equivalent to FMVSS No. 135 is ECE R13-H
- Light Vehicle Brake Standards were Harmonized in Mid-1990s to Promote Free Trade Among Countries
- NHTSA Has Not Included ABS Performance Requirements or Compliance Test Procedures in FMVSS No. 135 Comparable to those Contained in Annex 6 of ECE R13-H
- NHTSA Light Vehicle ABS Performance Test Development Project Reexamined Annex 6 to Identify Performance Requirements and Test Procedures for Inclusion in FMVSS No. 135



Summary of ECE R13-H, Annex 6

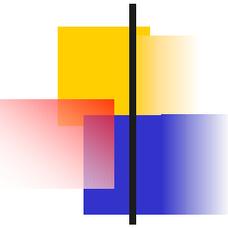
Two Sections of Annex 6 Address Adhesion Utilization and ABS Performance Characteristics

- ABS Adhesion Utilization Tests Assess the Effect of ABS on Vehicle's Ability to Stop by Comparing ABS Braking to Non-ABS Braking Performance
- ABS Performance Tests are Straight-line Stopping Tests that Assess:
 - Occurrences of Wheel Lockup
 - Vehicle deceleration after transitioning to a higher coefficient of friction surface
 - Trade-offs that exist between stability and adhesion utilization



Benefits and Disbenefits of Annex 6 Test Procedures

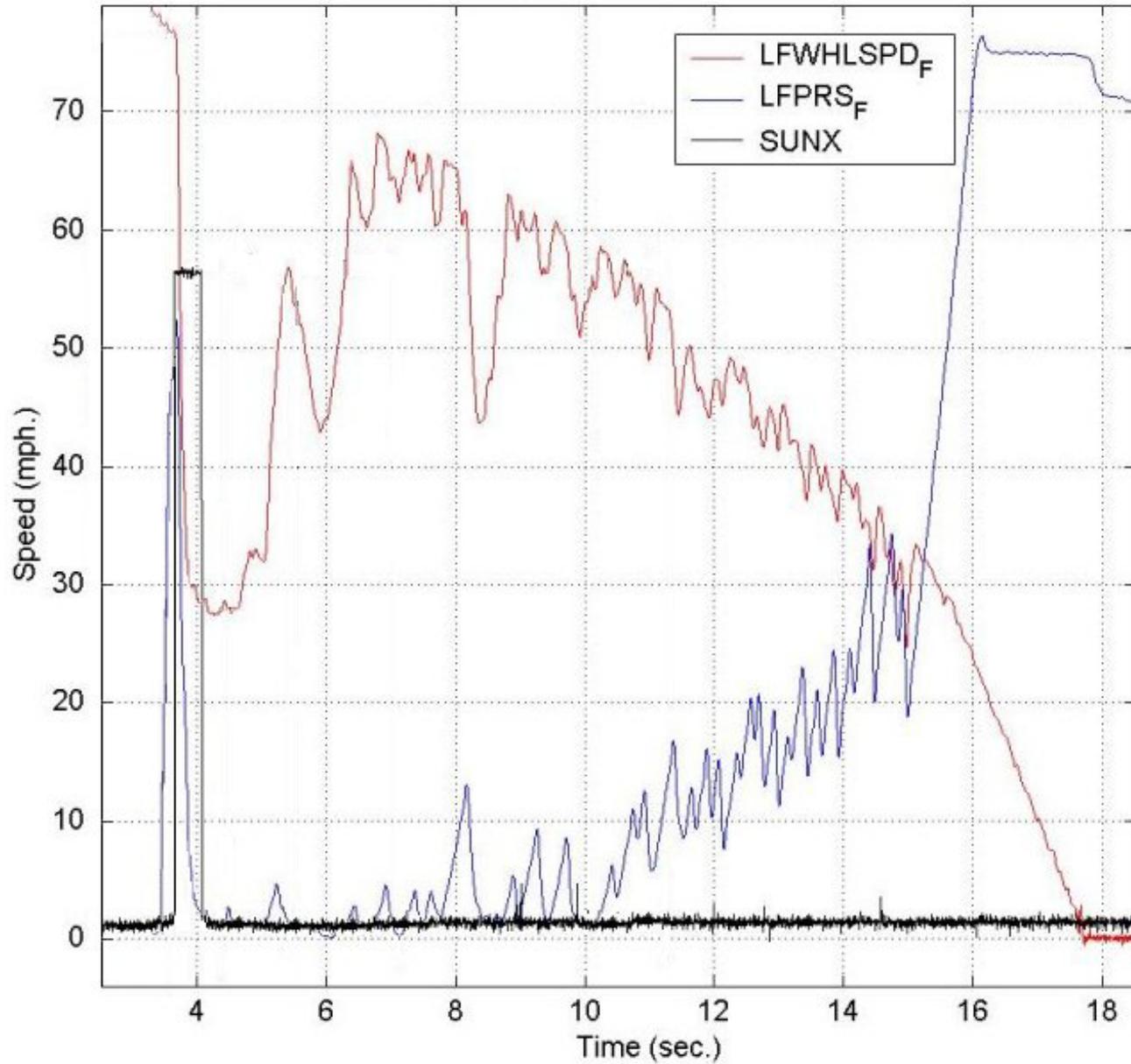
- Single-axle test procedures in Annex 6 for Determination of ABS Adhesion Utilization Produce Unreliable Results for Some Vehicles
 - Annex 6 Coefficient of Adhesion (Peak Friction Coefficient) is Difficult to Establish with a Passenger Vehicle
- The Adhesion Utilization Procedure in Annex 6 for Low Coefficient of Friction Surfaces is of Questionable Practical Value
- 75 Percent Adhesion Utilization for a Peak Friction Coefficient of 1.00 gives 0.75 g Deceleration



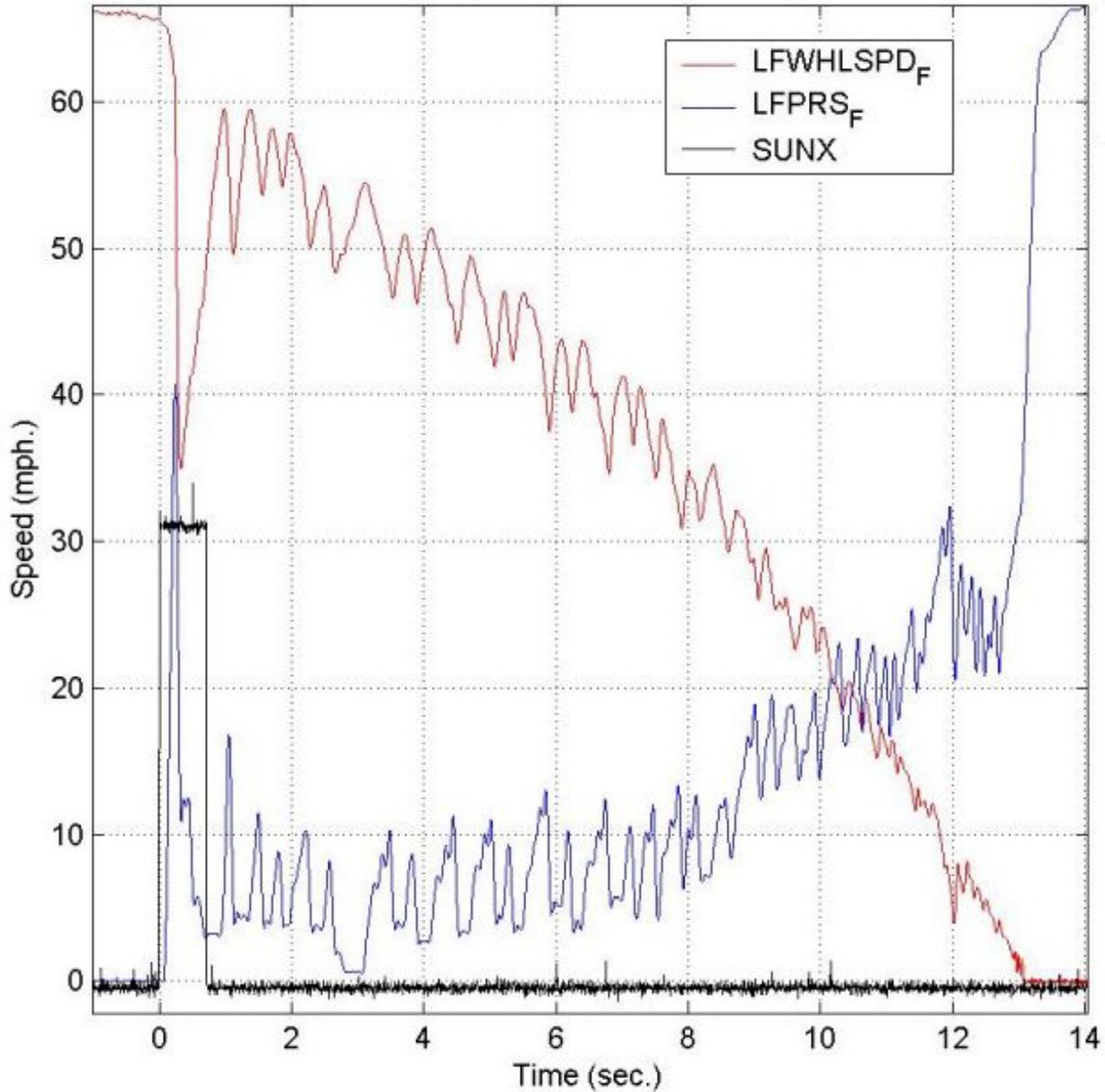
Benefits and Disbenefits of Annex 6 Test Procedures – Cont'd

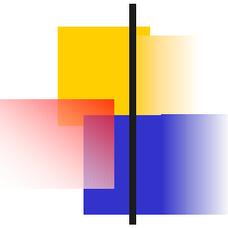
- Annex 6 ABS Performance Tests are Suitable for FMVSS No. 135
- Additional ABS Performance Tests have been Discussed such as Braking-in-a-Curve or Driving over Bumps
- Annex 6 Test Speeds are Probably Excessive for FMVSS No. 135

Wheel Speed and Brake Line Pressure



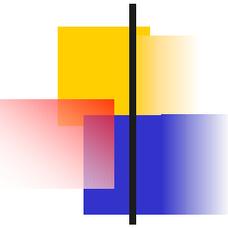
Wheel Speed and Brake Line Pressure





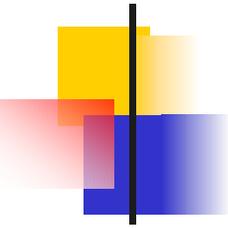
Alternatives to Annex 6 Adhesion Utilization Procedure

- Quantification of Test Surface PFC is Probably Not Necessary to Assess the Effect of ABS on Vehicle Stopping Performance
- Brake Performance can be Measured with Decelerations (ECE R13-H) or Stopping Distance Measurements (FMVSS No. 135)
 - ABS Active vs. ABS-Inactive, Two-axle Comparisons of Stopping Performance are Simpler than the Adhesion Utilization Technique
 - Stopping Distance Requirements for ABS could be Considered Instead of ABS Adhesion Utilization Requirements



Conclusions

- NHTSA does NOT Currently Plan to Mandate ABS for Light Vehicles
- Extensive Agency Light Vehicle ABS Research has been Conducted over the Past 5-7 Years
- Most Recent Crash Data Analysis Shows some Reduction in Crash Involvement for ABS-Equipped Vehicles
- No Significant Reduction has been Found in Overall Fatal Crash Involvement for ABS-Equipped Vehicles



Conclusions - Cont'd

- Driver Behavior and Vehicle Dynamics Evaluations have Not Revealed a Single Major Cause for Lack of Overall ABS Safety Benefits
- Agency Will Continue to Evaluate ABS Test Procedures and Performance Requirements with Emphasis on Harmonization with the European Regulations
- NHTSA Will Continue to Monitor Light Vehicle ABS Safety Performance and Conduct Research Programs

Questions or Comments?

